Investigation and comparison of cv. Koroneiki and cv. Mastoides extra virgin olive oils cultivated in the southern region of Peloponnese, according their sterolic and fatty acid profile

S. Agriopoulou[1*], V. Skiada[1], P. Tsarouhas[2], E. Stamatelopoulou[1] and T. Varzakas[1*]

[1]Department of Food Science and Technology, University of the Peloponnese, Antikalamos, 24100 Kalamata, Greece; sagriopoulou@gmail.com (S.A); vpskiada@yahoo.gr (V.S.); estamatel@gmail.com (E.S.); t.varzakas@us.uop.gr (T.V.)

[2]Department of Supply Chain Management (Logistics), International Hellenic University, Kanellopoulou 2, 60100 Katerini, Greece; ptsarouhas@ihu.gr (P.T.)

*Correspondence: t.varzakas@us.uop.gr (T.V.); sagriopoulou@gmail.com (S.A.)

Summary

Greece is ranked third among olive oil-producing countries, after Spain and Italy, with the region of Peloponnese representing one of the most important olive oil producing regions. However, very little information is available regarding the profile of the two major olive cultivars (cv. Koroneiki and cv. Mastoides) cultivated in the southern part of Peloponnese. Analysis of variance of the 112 analyzed olive oil samples showed substantial compositional differences in the fatty acid and sterolic profile between Koroneiki and Mastoides cultivars demonstrating that those chemical parameters could be a potential indicator for olive oil discrimination in terms of their botanical origin. As far as Kalamata PDO status is concerned, the detailed analysis of the examined Messinian (cv. Koroneiki) olive oil samples revealed major fluctuations from the relevant established EU regulatory limits. Results showed low concentrations of total sterols, with 66.7% of the examined samples being below the regulated set limits for Kalamata PDO status; high concentrations of campesterol, with a total of 21.7%, exceeding the legal maximum limit of 4.0% and a slight tendency of high total erythrodiol content. As this work is the first systematic attempt focusing on the evaluation of the chemical characteristics of the two dominant olive cultivars of southern Peloponnese, further in depth research, with a higher number of samples, more examined parameters and a higher number of crop years, is under way.

Introduction

Nowadays, the increased awareness regarding the beneficial impact and nutritional properties of extra virgin olive oil is a key factor which has led to a higher demand on international olive oil consumption. Olive cultivation is greatly spread in central Greece, with almost 40% of olive oil production being centered in Peloponnese with the prefecture of Messinia being the major olive growing area. In southern Peloponnese, among the predominant monovarietal olive oils produced are cv. Koroneiki and cv. Mastoides. Although there are many research publications related to cv. Koroneiki in different areas in Greece, no systematic work has been carried out on olive oil analysis from the Messinia region. Meanwhile, in August 2015, the European Commission approved the extension of the "Kalamata PDO olive oil," from the former province of Kalamata to the rest Regional Unit of Messinia, considerably enlarging the area covered by the PDO [1]. On this basis, the new "Kalamata PDO olive oil" introduces more stringent criteria than those laid down in the EC Regulation 2568/91 for extra virgin oil.

AIM OF THE STUDY

The first aim of this work was to profile the qualitative and chemical parameters of virgin olive oils obtained from the Messinia region as well as to evaluate to what extent olive oils of cv. Koroneiki meet the requirements of the amended EU regulation in order to be classified as "Kalamata PDO" certified olive oils. The second aim of this study was to evaluate and compare the chemical characteristics of Koroneiki and Mastoides olive oils originated from the southern region of Peloponnese emphasizing on the potential of their discrimination in terms of their botanical origin.

Materials and methods

- *Geographical distribution and sampling:* A total of one hundred and twelve (N=112) virgin olive oil samples were collected during the harvesting period 2014-2015 from two neighborhood regions in the southern region of Peloponnese in Greece. In particular, sixty nine (69) olive oil samples of Koroneiki cultivar originated from the region of Messinia and forty three (43) olive oil samples of Mastoides cultivar from the southeast part of Lakonia. All regions are characterized by similar climatic conditions. Olive samples were transferred to local oil mills for olive oil extraction under the same post-harvest conditions. The obtained olive oil samples were stored at 4°C until further analysis. All the examined chemical parameters were determined in triplicate.
- *Determination of the quality and chemical parameters*: Free fatty acid, peroxide value and spectroscopic indices (K_{232} and K_{268}) were carried out, following the analytical methods described in the Regulation EEC/2568/91 of the European Commission and later amendments [2]. The individual sterols, total sterols and triterpene dialcohols were determined according to the method adopted by EEC/2568/91 regulation, Annex VI. In accordance, fatty acid composition was determined according to the official method of the Regulation EEC/2568/91, Annex IV [2].
- *Statistical analysis* Results were expressed as mean values ± standard deviation (SD). Data were evaluated using MINITAB 18 software. Differences between means were tested for statistical significance using analysis of variance (ANOVA).

Results

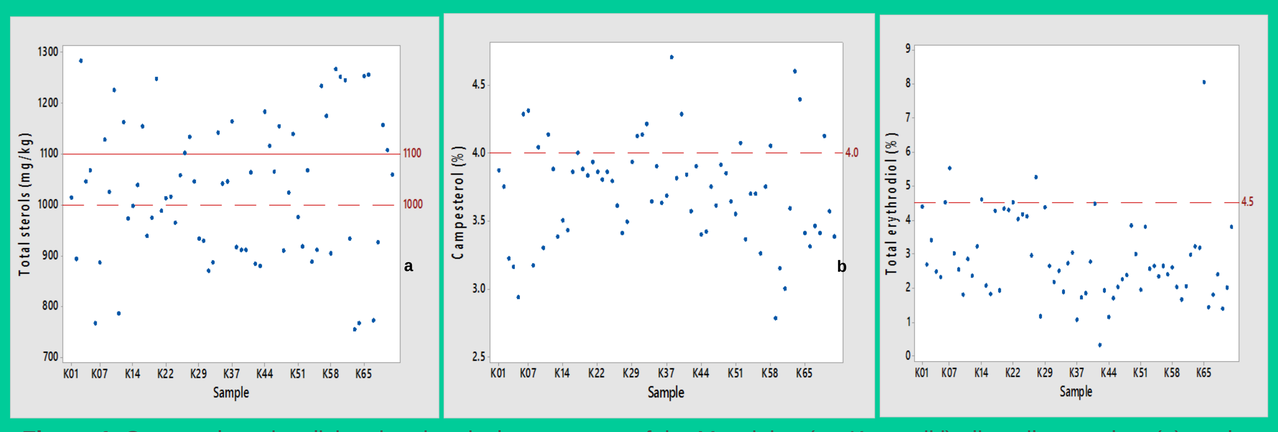

Figure 1. Scatter plots visualizing the chemical parameters of the Messinian (cv. Koroneiki) olive oils samples: (**a**) total sterols (43.5% of the examined samples did not surpass the EEC limit of 1000 mg/kg and 66.3% of the examined samples did not surpass the PDO limit of 1100 mg/kg in total sterols); (**b**) campesterol (21.7% of the examined samples exceeded the legal maximum of 4%); (**c**) total erythrodiol (8.06% of the examined samples exceeded the upper set limit of 4.5%) [3].

Table 1. Fatty acid profile of cv. Koroneiki and cv. Mastoides cultivated in southern Peloponnese [4].

Parameter	cv. Koroneiki (N=69)		cv. Mastoidis (N=58)		Calculated P-value	EEC limit for EVOO category
	Mean ±SD	Min-Max	Mean ±SD	Min-Max		
Myristic C14:0 (%)	0.01 ± 0.00	0.00–0.02	0,01±0.00	0.00–0.02	n.s	≤ 0,03
Palmitic C16:0 (%)	12.02 ± 0.74	9.54–13.56	12.29±0.77	9.96–13.28	n.s	7.50-20.00
Palmitoleic C16:1 (%)	0.92 ± 0.13	0.64–1.43	0,92±0.10	0.64–1.08	n.s	0.30-3.50
Heptadecanoic C17:0 (%)	0.05 ± 0.02	0.03–0.15	0.14±0.02	0.08–0.17	0.00	≤ 0.40
Heptadecenoic C17:1 (%)	0.08 ± 0.04	0.06–0.24	0.25±0.03	0.16–0.29	0.00	≤ 0.60
Stearic C18:0 (%)	2.53 ± 0.19	1.98–3.12	2.64±0.16	2.35–2.99	0.001	0.50-5.00
Oleic C18:1 (%)	76.70 ± 1.96	70.67–81.40	75.93±1.27	73.15–79.44	0.024	55.00-83.00
Linoleic C18:2 (%)	6.09 ± 1.60	4.20–12.01	6.44±0.69	5.11–8.13	n.s	2.50-21.00
Linolenic C18:3 (%)	0.68 ± 0.07	0.51–0.86	0.55±0.04	0.49–0.66	0.00	≤ 1.00
Arachidic C20:0 (%)	0.44 ± 0.03	0.33–0.50	0.39±0.02	0.35–0.44	0.00	≤ 0.60
Eicosenoic C20:1 (%)	0.31 ± 0.02	0.27–0.35	0.27±0.02	0.23–0.32	0.00	≤ 0.50
Behenic C22:0 (%)	0.14 ± 0.01	0.09–0.17	0.10±0.01	0.07–0.12	0.00	≤ 0.20
Lignoceric C24:0 (%)	0.05 ± 0.00	0.03–0.08	0.04±0.007	0.03–0.06	0.00	≤ 0,20

Table 2. Sterol profile of cv. Koroneiki and cv. Mastoides cultivated in southern Peloponnese [4].

Sterols and triterpene diols	cv. Koroneiki (N=69)	cv. Mastoidis (N=43)	Calculating P-value	EEC limit for EVOO category
	Mean ±SD	Mean ±SD		
Cholesterol (%)	0.11 ±0.03	0.12±0.03	0.017	≤ 0.5
24-methylene-cholesterol %	0.32±0.09	0.19±0.05	0.00	
Campesterol %	3.71±0.38	3.14±0.16	0.00	≤ 4.0
Campestanol %	0.05±0.03	0.04±0.02	n.s	< campesterol
Stigmasterol %	0.74±0.19	0.64±0.18	0.01	
Chlerosterol %	0.85±0.07	0.94±0.07	0.00	
β-Sitosterol %	80.73±3.73	84.12±2.69	0.00	
Sitostanol %	0.37±0.30	0.31±0.08	n.s	
Δ-5-avenasterol %	12.28±3.96	9.85±2.66	0.001	
Δ-5, 24-stigm/dienol %	0.29± 0.10	0.22±0.06	0.00	
Δ-7-stigmastenol %	0.19±0.09	0.18±0.09	n.s	≤ 0.5
Δ-7-avenasterol %	0.28±0.11	0.22±0.06	0.001	
Apparent b-Sitosterol %	94.63±1.07	95.45±0.29	0.00	≥ 93.0
Total Erythrodiol %	2.85±1.25	1.40±0.52	0.00	≤ 4.5
Total sterols (mg/kg)	1033.3±150.1	1219.6±109.2	0.00	≥1000

Conclusions

- Major fluctuations in the Messinian (cv. Koroneiki) olive oils were observed from the established EU regulatory limits (EEC 2568/91 & EC Reg. 510/2006 for Kalamata PDO olive oil).
- Messinian extra virgin olive oils show a clear tendency of low concentration in total sterols depicting a "special characteristic" for Koroneiki cultivar.
- Fatty acid compositional data and sterols have a high differentiation potential and can be suggested as authenticity indicators.

References

1.Official website of the European Union. Available on line: https://op.europa.eu/en/publication-detail/-/publication/a974b890-424a-11e5-9f5a-01aa75ed71a1/language-en

2. Commission Regulation (EEC). No. 2568/91 of 14 July 1991 on the characteristics of olive oil and olive residue oil and on the relevant methods of analysis. Off. J. Eur. Union 1991, L208, 1–8.

3. Skiada, V., Tsarouhas, P., Varzakas, T. Preliminary Study and Observation of "Kalamata PDO" Extra Virgin Olive Oil, in the Messinia Region, Southwest of Peloponnese (Greece). *Foods* **2019**, *8*, 610.

4. Skiada, V., Tsarouhas, P., Varzakas, T. Comparison and Discrimination of Two Major Monocultivar Extra Virgin Olive Oils in the Southern Region of Peloponnese, According to Specific Compositional/Traceability Markers. *Foods* **2020**, *9*, 155.